7150
DIGITAL MULTIMETER
MAINTENANCE MANUAL

Issue 3 April 1984

Part No. 71500011

SOLARTRON
Schlumberger

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Chapter 4 Dismantling and Reassembling Instructions

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INTRODUCTION

This manual contains maintenance information and it should be used in conjunction with the 7150 Digital Multimeter Operating Manual (Part No. 71500010) which is supplied with each instrument.

The information provided includes:-

Circuit diagrams along with circuit descriptions
Component layout diagrams and parts lists.
Setting-up and calibration procedures
Dismantling and reassembling instructions.

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GENERAL INFORMATION

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1.1 GENERAL

The Solartron 7150 Digital Multimeter is suitable for general-purpose bench applications and for systems use. It performs all common measurement functions and has a scale length in excess of 200000. The Multimeter has a built-in GP-IB Systems Interface port which conforms with the internationally-recognised IEEE 488 (1978) standard, thus ensuring the compatibility of the 7150 with a wide range of system devices produced both by Solartron and by other manufacturers.

The front panel controls permit all main functions to be selected or changed. Additional facilities become available when the 7150 is controlled remotely via the GP-IB Interface port.

1.2 SAFETY

The 7150 Multimeter has been designed in accordance with the recommendations of IEC348. To ensure the user's safety and the continued safe operation of the Multimeter, the user is advised to read carefully the procedures and specifications given in the Operating Manual and this Maintenance Manual.

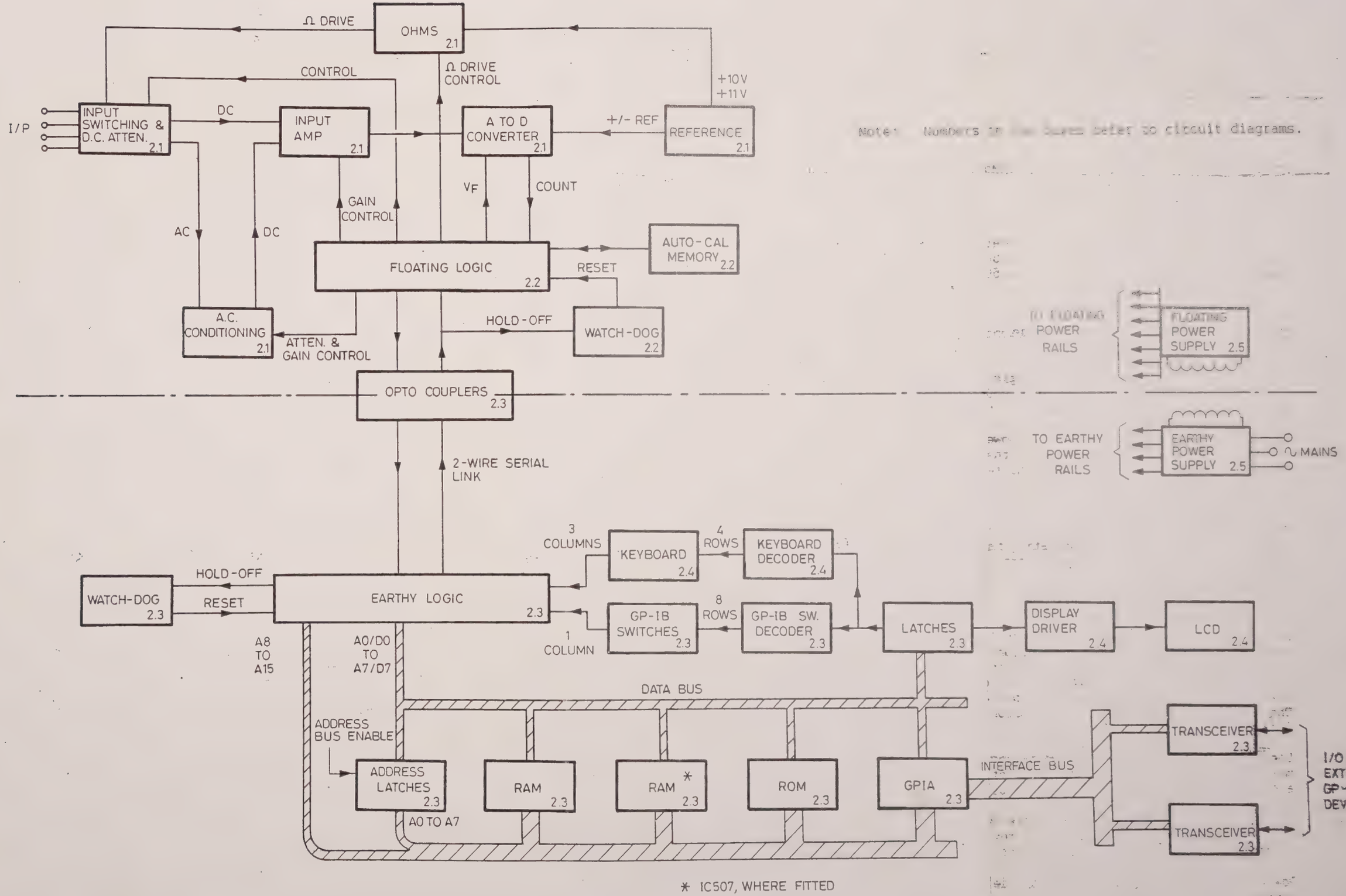
Care should always be exercised whenever the input leads are being connected or removed especially where high voltages are known to exist or high transients occur.

The 7150 is protected against measurement overload, up to 1.2kV peak on voltage measurement, and 240V rms on resistance measurements.

When using the 7150 on equipment which is capable of delivering high voltages (e.g. inductive circuitry giving high back-emfs) it is strongly recommended that the equipment under test is not switched off while the 7150 is still connected. The 7150 leads should be carefully disconnected before switching off the equipment, this will help to prevent the hazards of back-emfs. The following example illustrates this. Consider the inputs connected across the secondary of a large mains transformer. The very high input impedance of the 7150 is such that in the event of the mains supply being interrupted, the resultant back emf induced in the undamped secondary could be in the order of 100kV. This is obviously hazardous to the user and would certainly damage the 7150. User safety may be preserved by the inclusion of a switch between the 7150 and the transformer secondary. The switch could then be switched on and off while the transformer remained powered.

Whenever it is likely that the safety of the Multimeter has been impaired - e.g. if it shows visible signs of damage, if it fails to perform correctly or if the specifications have been exceeded in any way - it should be made inoperative and referred to a suitable repair depot.

Any maintenance, adjustment or repair of the Multimeter must only be carried out by skilled personnel. Such adjustment, maintenance or repair should be carried out in accordance with the procedures and precautions detailed in this Maintenance Manual.



Note: Numbers in box denote refer to circuit diagrams.

7150 MULTIMETER FUNCTIONAL BLOCK DIAGRA
FIG 1.

CHAPTER 2
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2.1 DC VOLTAGE INPUT (DIAG 2.1)

All multimeter inputs, including dc voltage, are processed by the A-to-D converter. With 7150, the operating range of the A-to-D converter is limited to ± 2.6 volts. The measurement range of the multimeter is extended beyond these limits by scaling all inputs to the 2 volt range. For example a 200 volt input scaled by a factor of X0.01 would be seen by the A-to-D converter as only 2 volts.

In practice scaling, or signal conditioning, is a two-stage operation performed by the dc input attenuator (for dc volts) and the input amplifier. The input amplifier is described on page 2.5.

The circuit has two main functions:

1. Signal Conditioning; for dc voltage inputs.

2. Input Switching; to the input amplifier.

Signal Conditioning

The circuit shows the dc voltage input attenuator, R1A to R1D. The attenuator is switched by FETs TR7, TR8 and relay RLK in response to range control inputs from the floating logic. The attenuator setting, either X1, X0.01 or X.001, depends upon the selected voltage range i.e.:

RANGE(V)	ATTENUATION	CIRCUIT PATH
0.2) 2)	X1	Direct to Input Amp via RLB
20) 200)	X0.01	RLK,TR7, with RLB open
1000	X0.001	RLK and TR8, with RLB open

The attenuated outputs are amplified by the input amplifier. The gain of the amplifier is arranged to be X1 or X10 in order to ensure satisfactory scaling at the A-to-D converter.

Input Switching

DC voltage inputs to the input amplifier are selected via series FET TR5. When TR5 is ON, shunt FET TR6 is OFF and vice versa. TR6 is switched ON during ac (voltage or current) measurement, during dc current measurement and during "drift correct" (see page 2.5).

2.2 AC VOLTAGE INPUT (DIAG 2.1)

In Vac operating mode, inputs are first scaled to the 2 volt range by the ac signal conditioning circuits and then converted into a dc voltage. Mode control signals switch the converted output to the dc input amplifier. A-to-D conversion follows in the manner described on page 2.7.

Signal Conditioning

This function is performed by the ac input attenuator which is switched by IC18,TR1, and TR2, and by operational amplifier IC15, whose gain is set, via IC18, to be either X1 or X10.

For inputs on the 2 volt range, no signal conditioning is necessary; quad switch IC18 selects the gain of IC15 (via resistors R21A and R21B) to be at unity with inputs to the amplifier direct through RLA, RLE and RLF contacts. The overall circuit gain for other input ranges is selected by TR1 and IC18 in response to range control inputs from the floating logic. Details are given in the following table:-

RANGE (V)	ATTENUATION	AMP I/P (V)	GAIN	AMP O/P (V)
2	X1	2	X1	2
20	X0.01	0.2	X10	2
200	X0.01	2	X1	2
1000	X0.001	1	X1	1

AC-DC Conversion

AC to DC conversion is carried out by true rms-to-dc converter IC21. The maximum 2V output from this IC is switched to the dc input amplifier IC1 via the shunt input FET TR6 via quad switch IC5.

2.3 RESISTANCE MEASUREMENT (DIAG 2.1)

Resistance measurement is achieved by measuring the voltage developed across the unknown resistance when a known current is passed through it. The resultant voltage is then measured by the dc voltage measurement circuit.

Current Generator Circuit

IC3 is a precision operational amplifier which is connected to +10 volts from the reference supply circuit. The other amplifier input is the +11 volts reference supply via R15 resistor chain. Thus IC3 will drive TR3 to maintain a 1 volt differential across R15.

Control inputs from the logic circuitry switch R15 resistor chain (via TR4, TR9 and RLD) to define four test currents, one for each ohms range. For example, with the contacts in the positions shown on the diagram, ie with the 20MΩ resistance range selected, the available test

current $\frac{V}{R}$:

$$= \frac{1}{10 \times 10^{-6}}$$

$$= 100nA$$

The table below shows the test currents for each range:

NOMINAL RANGE	TEST CURRENT
20MΩ	100nA
2MΩ	1µA
200KΩ	10µA
20KΩ	100µA

Four-wire Resistance Checks

During four-wire resistance checks, all of the current available at the Hi ohms source terminal should be returned to source via the LOΩ source terminal.

On the lower resistance ranges (2MΩ, 200kΩ and 20KΩ) the logic control, via IC2, also switches the resistor chain R7, R27 and R56 which is connected to the Lo source terminal and to the -3V reference supply. This part of the circuit acts as a calibrated current sink for the test current generator.

Input Protection

Input protection for the resistance measurement circuit is provided by resistor R4 (22k) which is in series with both I+ and V+ input terminals. Diodes D2 and D25 limit the voltage at the junction of TR3 and R4 to +5.3V and -2.6V.

2.4 CURRENT INPUT (DIAG 2.1)

Current measurement is achieved by measuring the potential across a known resistance when the current to be measured flows through it. The voltage obtained can be measured by the dc input amplifier, either direct or, for ac inputs, via the AC-DC converter.

DC Current Input

Resistor R3 is a 0.1Ω shunt resistor through which the current to be measured flows. The potential across R3 is switched to the dc input amplifier IC1 via quad switch IC5 and shunt FET TR6. The gain of IC1 is set to X10 in dc current mode; the amplifier output is thus correctly scaled on the 2 volt range for A-to-D conversion.

AC Current Input

In ac mode, the potential across shunt resistor R3 is switched, via quad switch, IC18 and FET TR2, to the ac operational amplifier IC15. The gain of this amplifier is set to X10 in ac current mode, thus the inputs to the AC-DC converter are scaled to the 2 volt input range.

After AC-DC conversion, the output voltage is switched to the dc input amplifier via quad switch IC5 and shunt FET TR6.

Protection

Current overload protection is made by a 2 amp fuse.

2.5 INPUT AMPLIFIER (DIAG 2.1)

Input amplifier IC1 is a precision FET input operational amplifier. Inputs to the amplifier are selected either by switching on TR5 (series FET) or TR6 (shunt FET) depending on the multimeter's function. For dc measurement functions (including resistance) TR5 conducts; for ac functions or when a drift correction is carried out, TR6 conducts.

The gain of IC1 is controlled by IC2 in response to range control signals from the floating logic. IC2 is a quad switch connected across IC1 feedback resistors R18 and R19. IC2 switching sets the gain of IC1 to be either X1 or X10 depending on the selected input range or measurement function. Gain settings are summarised as follows:

IC1 Gain for DC Voltage Ranges

RANGE (V)	GAIN
0.2	X10
2	X1
20	X10
200	X1
1000	X1

IC1 Gain for DC Current Mode

RANGE (mA)	GAIN
2000	X10

AC Current Mode

RANGE (mA)	GAIN (IC1)
2000	X1

Drift Correct

A "drift correct" is necessary in order to compensate for any drift originating in the input amplifier or from the A-to-D Converter. Typically, drift results from component aging or from variations in temperature.

During a drift correct cycle, the input amplifier is isolated from any measured input (series FET off) and connected to signal 0V (shunt FET on). With zero input to the amplifier, any resultant count must be due to drift. This is subtracted from a measurement count to provide a nett result which is proportional only to the value at the multimeter's input terminals.

A drift correction is carried out automatically:

1. Every 10 seconds
2. After a change of setting, e.g. range or mode.

With the multimeter in remote, the drift correct cycle can be controlled using command Yn (where n is an integer between 0 and 2). For more information on command Yn and other commands, refer to the 7150 Operating Manual.

Input Protection

Input protection against voltage overload for this input amplifier is by spark-gap SG2 (1400V Nom.) which is connected across the V Hi and Lo terminals. Resistor R9 (100kΩ) is a current limiter and diodes D6 and D26 limit series inputs to the amplifier to ± 2.6 Volts.

2.6 A-TO-D CONVERTER (DIAG 2.1)

This circuit converts the analogue output from the input amplifier into pulses. These are used to gate clock into a reversible counter in the MPU,to produce a count proportional to the measured input.

The Integrator

The integrator, IC8A has the following inputs connected to its summing point:

1 The input to be measured

2 The forcing waveform

3 + reference or - reference

With zero input to the multimeter and a 300Hz forcing square wave applied continuously to the integrator, the output is driven alternatively positive and negative through the thresholds of the comparators, IC9 and IC10.

The states of the two comparators are followed by bistable IC11 which synchronises the two transitions to clock. Outputs from IC11 control analogue switch IC16 which switches the + and - reference supplies (through 0V) to the integrator input. This closed loop feedback arrangement is such that irrespective of the input to the integrator, the output will always remain dynamically balanced about zero.

The + and - reference levels from IC11 are NANDded by IC17a to produce a single clock-synchronised pulse-train for counting circuits in the MPU.

2.7 REFERENCE SUPPLY (DIAG 2.1)

This circuit generates the +10V and +11V supplies for the ohms current generator and the + and - 3.1V reference supplies for the A-to-D converter.

Zener D20 regulates IC4 input to be +3.1V. This input, via IC6A and IC16, is the + reference supply for the A-to-D converter whilst the inverted output from IC4 is the -3.1V reference supply.

The + reference voltage is also used as the input to IC6B. This amplifier drives a current through R14, R57 and R16 in order to maintain the amplifier at balance. The resistor chain is tapped to provide the +10V and +11V reference voltages for the ohms current generator.

2.8 FLOATING LOGIC (DIAG 2.2)

This circuit includes the floating logic MPU, IC103. This IC communicates with the earthy logic MPU via a 2-wire serial link. The circuit can be considered as having four separate functions:

1. Controls range and mode switching on the analogue pcb.

2. Generates the forcing waveform for the A-to-D converter.

3. Counts the output from the A-to-D converter (i.e. the measured value).

4. Stores calibration constants and checksum for use during auto-cal procedures.

Note The circuit automatically resets to a known state in the event of a system lockout.

Analogue Control Lines

These MPU outputs are connected to drivers, comparators and bi-lateral switches on the analogue pcb. The outputs, via their respective switching devices, correctly configure the circuits for the selected multimeter range and function.

Forcing Waveform

The "timer-out" signal from the MPU is a 300Hz waveform which is used to generate the forcing waveform for the A-to-D converter. The TTL level signal is converted into a 0 to 8V pk square wave by bi-lateral switch IC5 in the analogue circuit.

Counting Circuit

Timer-in is an input to the MPU which is derived from the A-to-D converter. The input is a single, clock synchronised pulse-train; the pulse widths indicating alternately,the length of time the + and - reference voltages were applied in order to balance the integrator. Within the MPU, these pulses are used to gate clock into a reversible counter to produce a nett count proportional to the measured input.

Non-Volatile Memories

ICs 105 and 106 are EAROMs which hold the automatic calibration program for the multimeter and the calibration constants for each mode/range selected.

Floating Logic Reset Watchdog

This circuit causes the floating MPU to be reset in the event of system lockout. The circuit operation is similar to that described for the earthy logic reset circuit (page 2.11).

A 1.2288 MHz, clock derived output from the MPU is divided by a 12-bit binary counter IC107. The 300Hz (3.333 ms period) output from this IC is counted by a 4-bit counter, IC108.

The serial link TX DATA line from the earthy MPU, is also connected to IC108. This input holds-off the RESET output unless the RX DATA line is inactive for more than 26.664 ms (8 x period).

With the RESET line active, bistable IC11 (see A-to-D converter) is also reset, thus MPU pin 8 (TIMER IN) is set to a logic 1 state. Pins 8, 9 and 10 are set to this state at initialisation.

2.9 EARTHY LOGIC (DIAG 2.3)

The earthy logic includes the main microprocessor (MPU) set, the device and GP-IB address switch decoders, the GP-IB interface and the watchdog reset circuitry. Data exchange between the earthy and floating logic is via a two-wire serial link.

MPU Set

The MPU set comprises the following:

1. IC510; 8-bit MPU

2. IC508; 8K x 8 bit ROM

3. IC506; 2K x 8 bit RAM

4. IC507; 128 x 8 bit RAM (where fitted)

The MPU can be either a Motorola type 6801 or alternatively, an Hitachi type 6303. Two split pads are included on the pcb so that the circuit can be configured for either type. For a 6801, only SP504 is linked. For a 6303, only SP505 is linked.

Address Decoders

The MPU addresses the various bus connected devices and the watchdog reset circuit via 3-to-8 decoder IC512. The ROM (IC508)is separately addressed via address line A15 which, when active, deselects IC512. Both the ROM and IC511 require E (0.6144 MHz)to be gated-in with the address decode. This is achieved via IC515,gates A and B. IC511 is an octal latch driven from the bus which communicates with the LCD driver and also provides lines for strobing the keyboard and, at power-up, the GP-IB address switches.

GP-IB Interface

The GP-IB permits data exchange between the 7150 multimeter and any suitable device conforming to IEEE488 1978 (standard digital interface for programmable instrumentation). The interface, an integral part of the multimeter, comprises a general purpose interface adapter (GPIA) IC503, two bus transceivers, IC501 and IC502, and GP-IB address switch S501(see Address Decodes).

The GPIA, with associated bus transceivers, provides a means of connecting the multimeter's MPU with external devices connected to the GP-IB. Handshake lines; DAV, NRFD and NDAC are handled automatically by the GPIA. The GPIA comprises fifteen registers, (one, the address switch register, is external to the chip.) Seven of the registers may be written into by the MPU and, depending on the state of control lines R/$\overline{W}$ and RS0 to RS2, eight may be read by the MPU. The MPU enables the chip by sending address $8000. The interface includes two octal bidirectional bus transceivers, IC501 and IC502. Each transceiver comprises eight driver/receiver pairs. Either the driver or the receiver of each pair is enabled by a send/receive input (T/R1 and T/R2 on the diagram) with the disabled output forced to a high impedance state.

Reset Watchdog Circuit

This circuit resets the MPU and the display in the event of a system lockout.

A 0.6144 MHz, clock-derived output from the MPU is further divided by 12-bit binary counter IC516. The 150 Hz (6.6 ms period) output from this IC is counted by 4-bit binary counter, IC517.

With the MPU functioning normally, IC517 is loaded every 10 ms (decode $4000) to "hold-off" the RESET output. If pin 1 of IC 517 remains inactive for more than 53.3ms (8 x period) then IC517 output resets both the MPU and the display.

2.10 DISPLAY AND KEYBOARD (DIAG 2.4)

This circuit has two main functions:

1. To decode display and command data.

2. To transfer keyboard selections to the MPU.

Display

The display circuit includes custom LCD, X401. Electrically the LCD can be considered as being a set of 8, 3 x 3 matrices whose columns are separately controlled, but whose rows are common:

The intersections between the rows and columns form active elements which correspond to individual segments, decimal points, or annunciators that appear on the display. Most of the 3 x 3 matrices use their 9 active elements as follows:

7-segment numerical character	(7)
decimal point	(1)
annunciator (e.g. FILT)	(1)

The extreme R.H. matrix is used only to provide the special units symbols (e.g. KΩ), whilst the extreme L.H. matrix is used to display only the numerical character 1 and a minus sign.

IC401 is the driver for the LCD. It is serially interfaced with IC510 (earthy logic MPU) via lines SI, SCK, CS, C/D and BUSY.

With the chip select (CS) pulled low, data may be sent on the serial input (SI) line. The data are clocked bit-by-bit on each positive transition of the serial clock (SCK). On the eighth positive transition of SCK, the BUSY line is made active low by IC401 until it is ready to accept more data.

The serial input may simply be data for display, in which case the control data (C/D) line remains in its active low state. If however a driver command is sent, for example the command to blank the display or one to cause it to flash, then C/D will be set to the logic '1' state.

Keyboard

The (vertical) column outputs from the keyboard are connected directly to the MPU and, with no selections made, held in the logic 1 state via pull-up resistors on the earthy logic pcb. Keyboard (horizontal) rows are scanned via output latch IC511 and BCD-to-decimal decoder, IC402. Thus keyboard settings data are made available to the MPU.

2.11 POWER SUPPLIES (DIAGS 2.5 and 2.6)

Two circuit diagrams are shown. The first (Diag 2.5), is applicable to all multimeters from serial number 300921 onwards. Multimeters with earlier issue serial numbers, have power supplies which conform to the circuit shown on Diag 2.6.

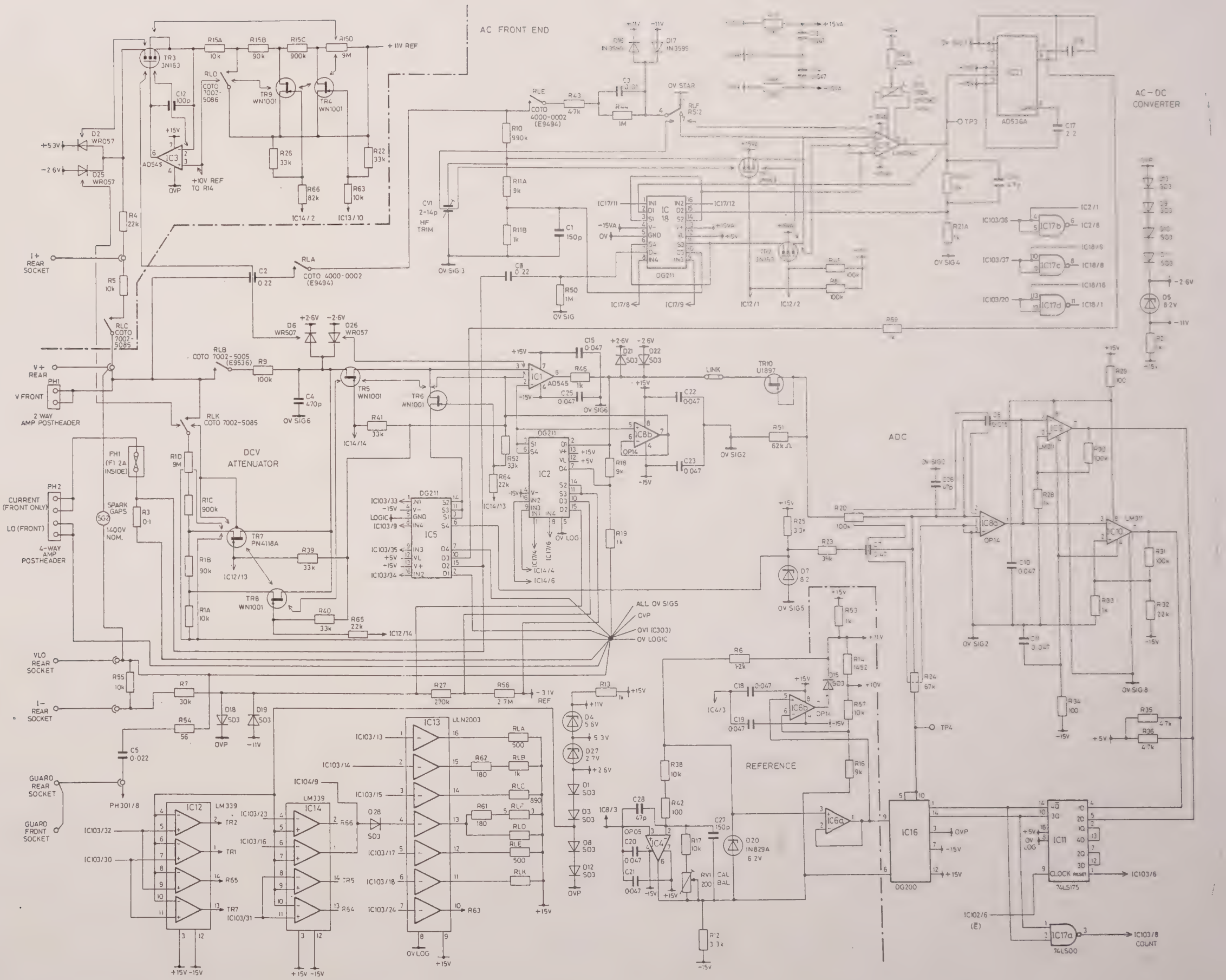
The circuits provide both earthy and floating power for the multimeter.

Multi-purpose Mains Input Unit

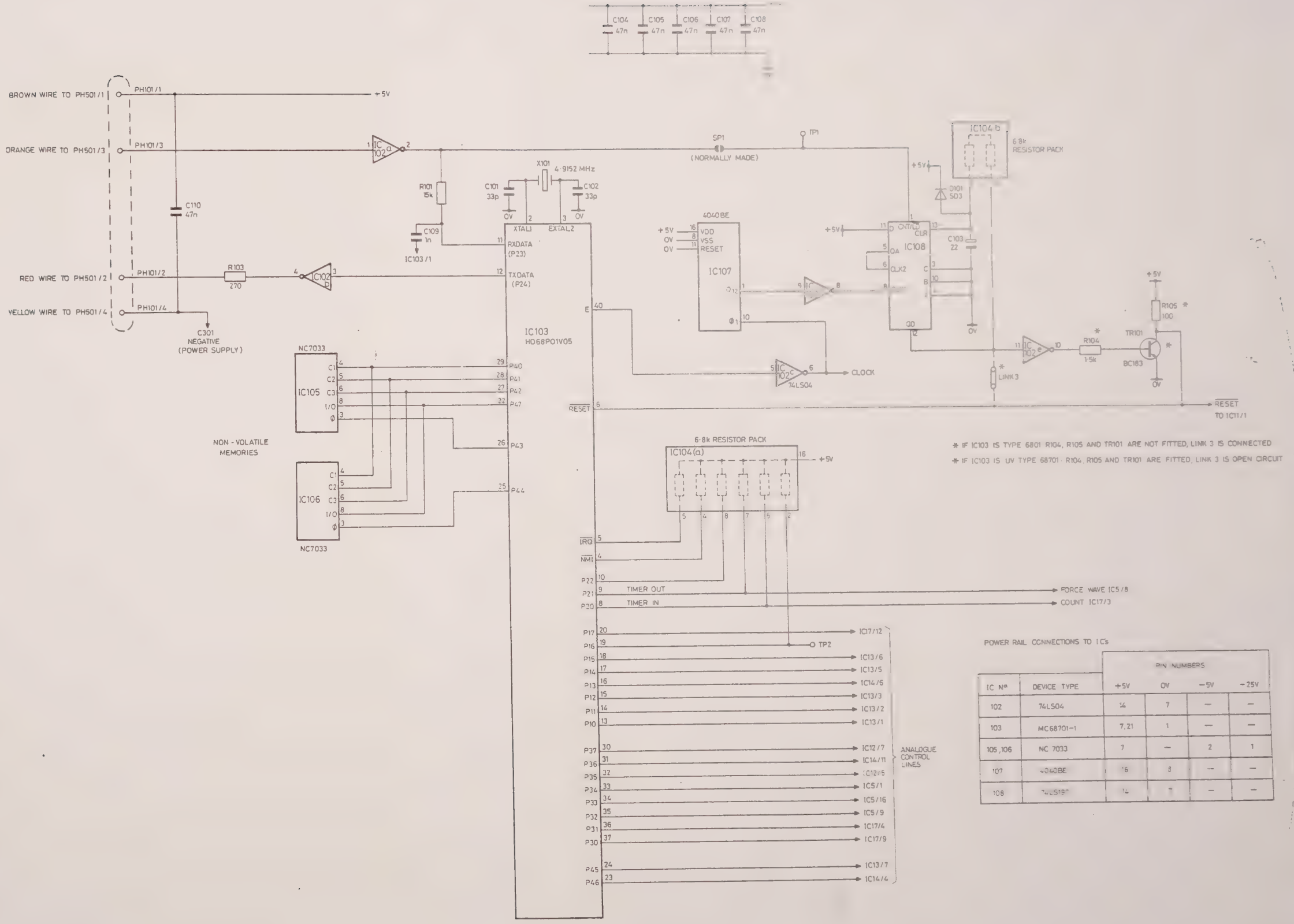
Both diagrams include a multi-purpose mains input unit. Contacts a to e within the unit are set by positioning the mains selector/cam assembly, to the required voltage setting as seen through the aperture at the rear of the multimeter.

Cal. Enable

IC307 acts as a switch for the -25V output. This supply, which is required by the auto-calibration EAPROMs, will only be made available when the transistor conducts, i.e. when the calibration jack-plug is inserted. This is to prevent unauthorised interference to calibration coefficients.



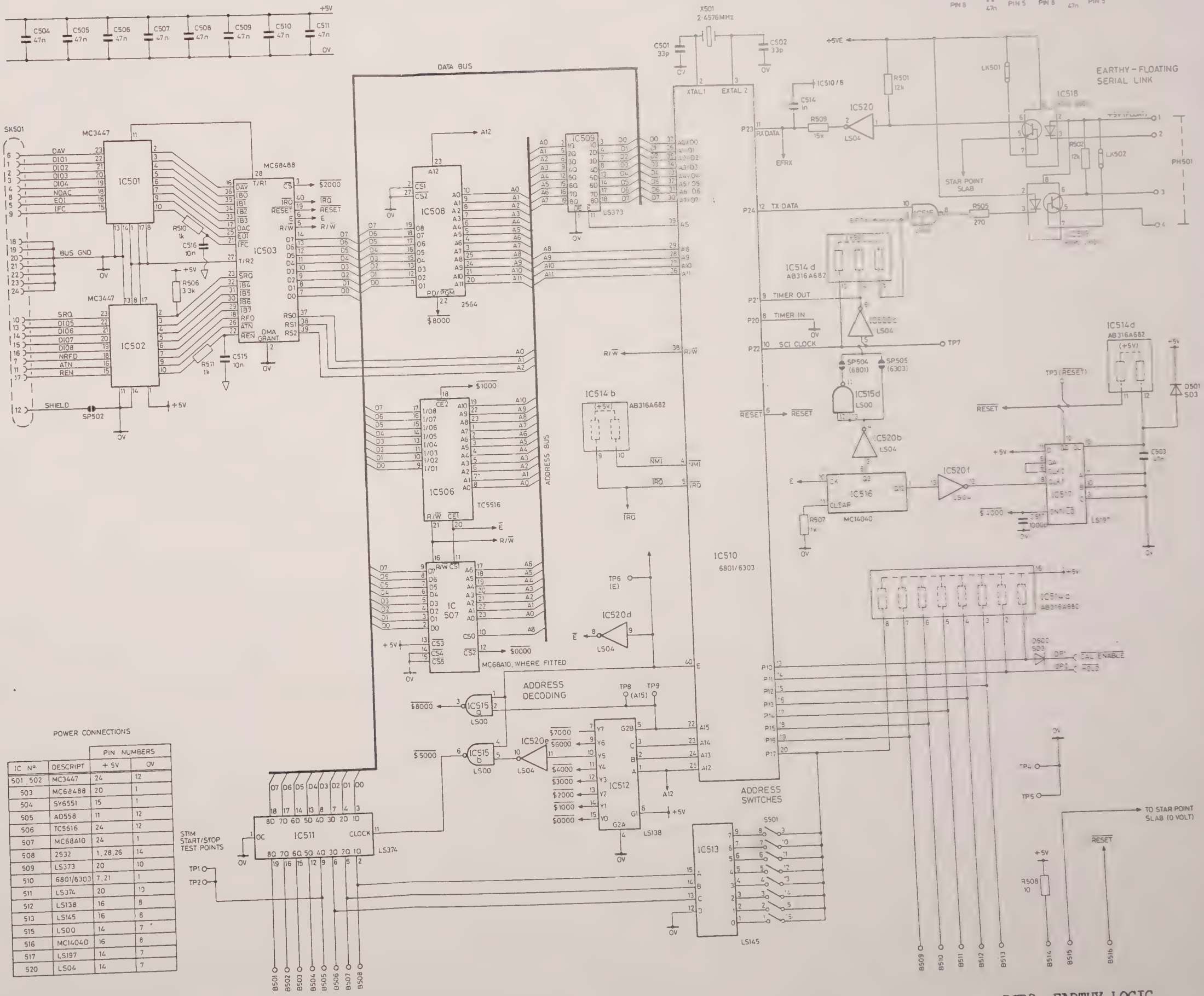
PCB 1, SHT 1 OF 2, FLOATING ANALOGUE (Drg. No. 71507501 DIAG 2.1



POWER RAIL CONNECTIONS TO ICs

IC Nº	DEVICE TYPE	PIN NUMBERS +5V	0V	−5V	−25V
102	74LS04	14	7	—	—
103	MC68701-1	7,21	1	—	—
105,106	NC 7033	7	—	2	1
107	4040BE	16	8	—	—
108	74LS193	16	8	—	—

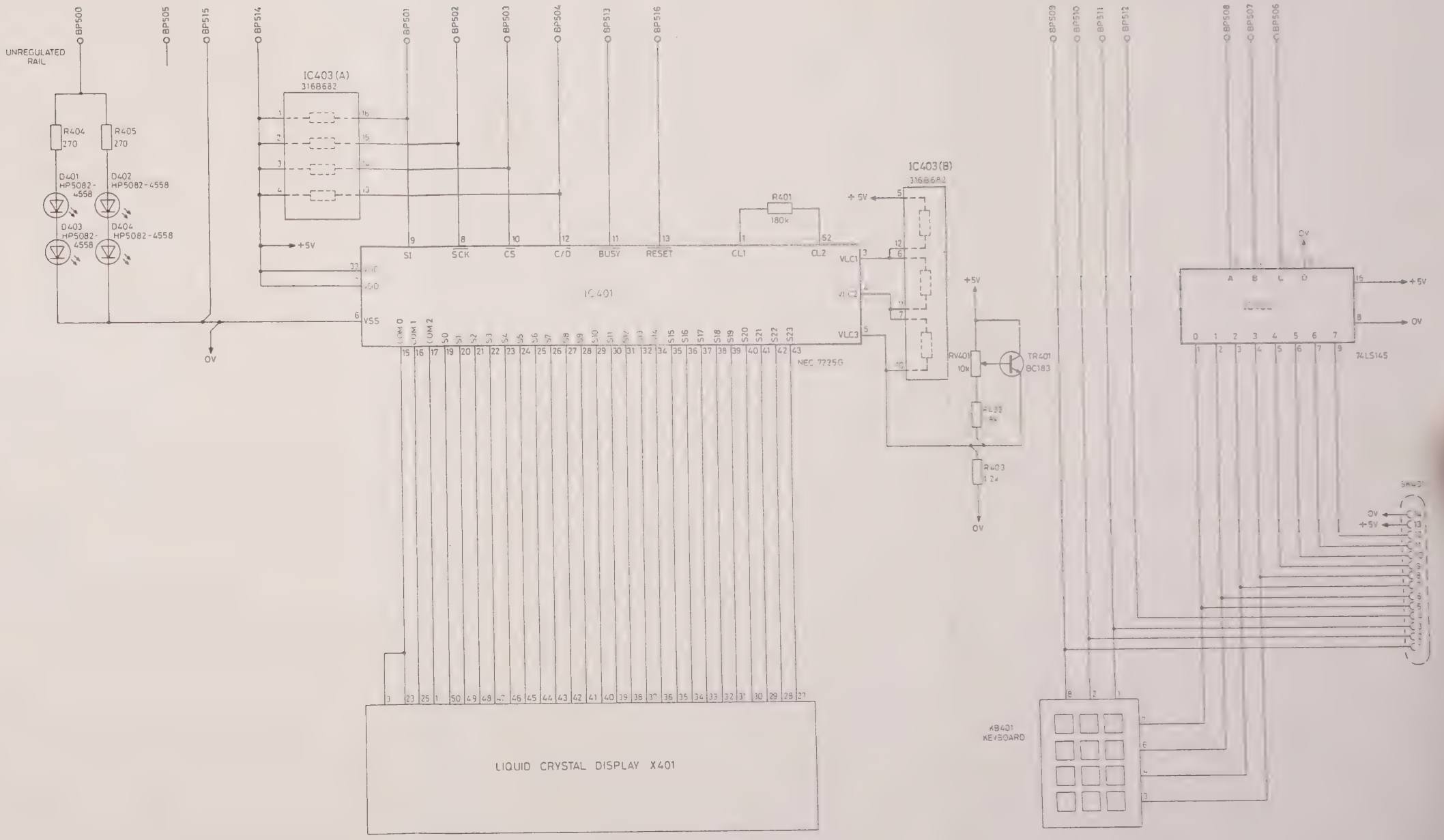
PCB 1, SHT 2 OF 2, FLOATING ANALOGUE (Drg. No. 71507501 DIAG 2.2

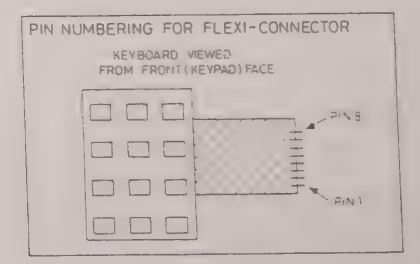


POWER CONNECTIONS

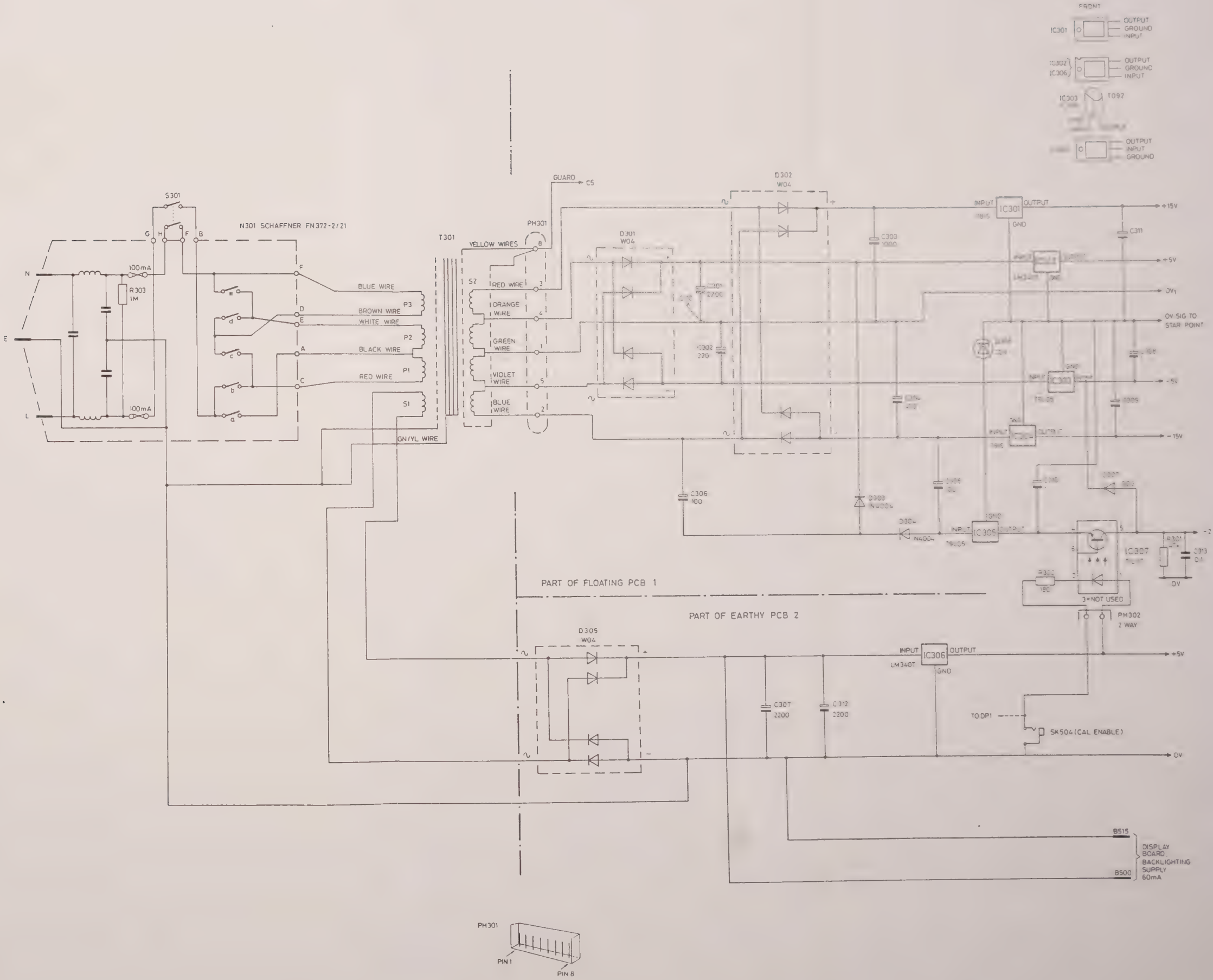
IC No.	DESCRIPT	PIN NUMBERS	
		+ 5V	0V
501, 502	MC3447	24	12
503	MC68488	20	1
504	SY6551	15	1
505	AD558	11	12
506	TC5516	24	12
507	MC68A10	24	1
508	2532	1, 28, 26	14
509	LS373	20	10
510	6801/6303	7, 21	1
511	LS374	20	10
512	LS138	16	8
513	LS145	16	8
515	LS00	14	7
516	MC14040	16	8
517	LS197	14	7
520	LS04	14	7

PCB2, EARTHY LOGIC
(Drg. No 71507502) DIAG 2.3

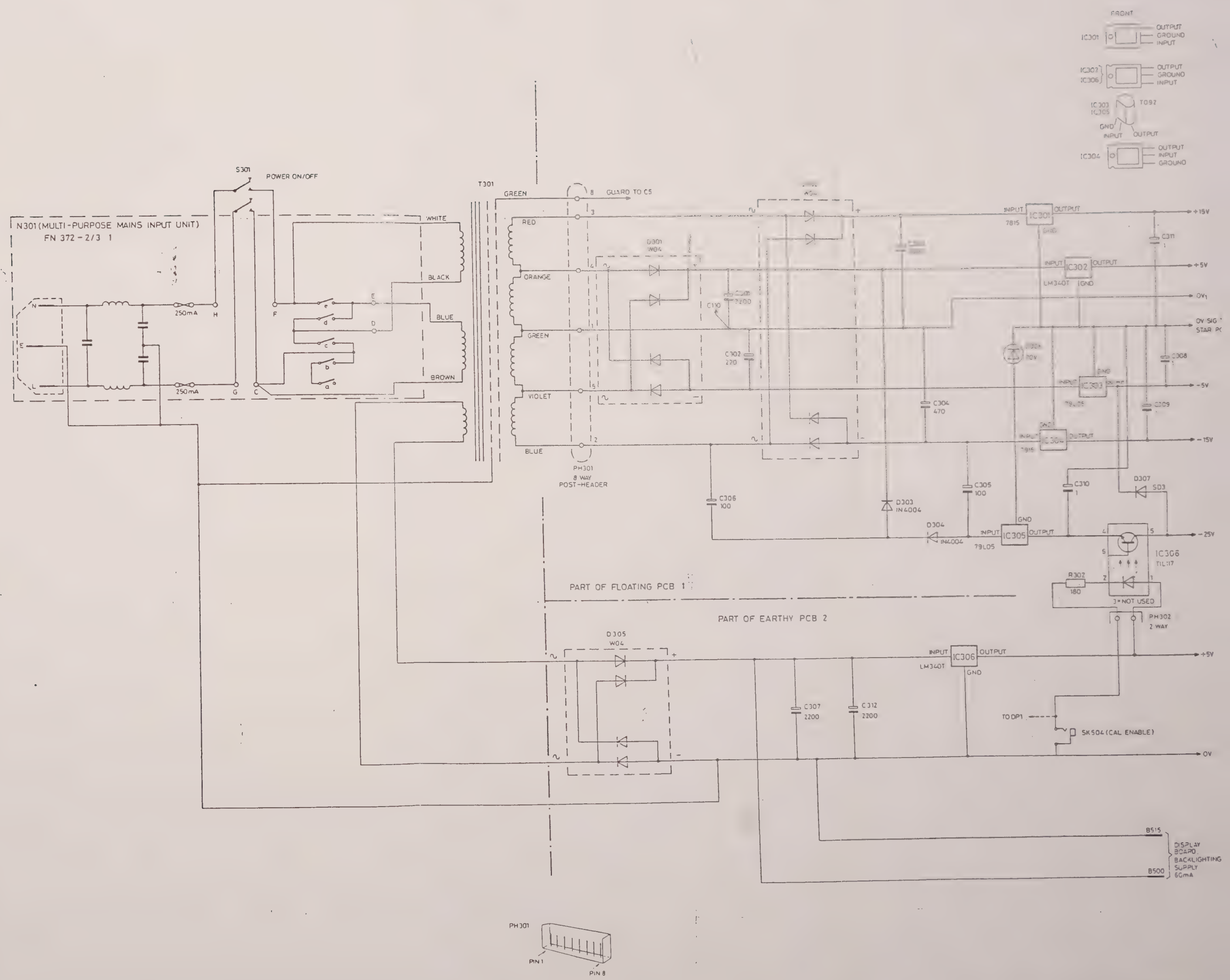




PCB 3, DISPLAY AND KEYBOARD
(Drg. No 71507503) DIAG 2.4



POWER SUPPLY CIRCUIT DIAGRAM No. 1
(Drg. No 71507001) DIAG 2.5



POWER SUPPLY CIRCUIT DIAGRAM No.
DIAG 2.

CHAPTER 3
SETTING-UP AND CALIBRATION PROCEDURES

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3.1 GENERAL

These procedures enable the instrument to be set-up and calibrated to the factory despatch standards.

The procedures are categorised into the following sections:

1. Setting-up procedures.
2. Initial calibration procedures
3. Final calibration procedures.

3.2 SAFETY

This instrument must be disconnected from the mains supply when partially dismantling it to gain access to the preset controls and also when it is being reassembled.

When adjusting preset controls beware of high test voltages, the guard potential on the guard plate and also the mains input supply.

3.3 GAINING ACCESS TO PRESET CONTROLS

To gain access to the preset controls refer to the dismantling instructions given in Chapter 4. The various preset controls are identified in Fig 3.1.

3.4 CALIBRATION METHOD

Due to the automatic calibration circuits incorporated into the 7150 design, the 7150 can only be calibrated by connecting it to an IEEE 488/GP-IB and using the bus controller (e.g. a microcomputer) to select the appropriate calibration commands and also the required 7150 measurement function and range.

The calibration procedures given in this chapter can be used without requiring application software for the controller. The operator can enter the appropriate command string on the controller's keyboard, where applicable, for each test item given in the Initial and Final Calibration Procedures.

The following example calibration method demonstrates the use of the controller in conjunction with the 7150 and the calibration source and is the method to be followed when using the Initial and Final Calibration procedures.

As a faster alternative to the above method of calibration, a calibration program can be written for the controller. A description of a typical calibration program is given in the 7150 Remote Control Manual.

Solartron can supply, on tape cassettes, a calibration program for the more common types of controllers.

3.5 CALIBRATION SOURCE

It is recommended that the calibration source has an accuracy of at least two times better than the accuracy specified for the various 7150 modes of operation. The 7150 specification is given in the associated Operating Manual and the percentage accuracy is as follows:-

Range	Accuracy
DC Volts	0.002%
DC Current	0.002%
AC Volts	0.1%
AC Current	0.1%
Resistance	0.004%

The Fluke 5205B calibrator is used as the example calibration source in these procedures. On published data, the Fluke 5205B does not provide the required accuracy as previously stated. However the Fluke 5205B outputs can be compared against an instrument of higher accuracy, e.g. Solartron DMM 7075, and the comparative difference variables for each output recorded. The outputs from the Fluke are then adjusted to compensate for the difference variable figures which form the calibration reference source.

3.6 EXAMPLE CALIBRATION METHOD

The Example Calibration Method can be summarised as follows:

1. Select the Calibration mode, i.e. send the command C1.
2. Select the desired mode and range to be calibrated and perform the calibrating sequence. Repeat for each range/mode to be calibrated. Only one range of one mode can be calibrated at a time and calibration is normally done range by range for the particular mode.
3. De-select the Calibration mode, i.e. send the command CØ to re-select Normal mode.

The 7150 address switch on the rear panel should be set as indicated below:

ADDRESS 1, 2, 3, 8, 16	:	As required (0 to 30)
LISTEN ONLY	:	OFF
TALK ONLY	:	OFF
GP-IB ON	:	ON

3.6.1. Equipment Required

Calibrator (for voltage, resistance and current)
Controller
GP-IB cable

3.6.2. Entering Calibration Mode

Before sending the command C1, insert a 2mm jack plug into the CAL socket on the 7150 rear panel; the terminals in the plug must be shorted together, either within the plug itself or using a switch to which the plug is connected. Attempts to calibrate in the absence of this shorting jack will result in error message being issued by the 7150. The shorted jack plug must remain fitted throughout the calibration and be removed when calibration is complete.

NB Never switch mains power on or off when the shorted jack plug is fitted in the CAL socket otherwise the internal calibration constants may be altered.

1. With the 7150 switched on, insert the shorted jack plug into the CAL socket on the rear panel. The CAL annunciator in the display will flash on and off, this acts as a warning that the jack plug is fitted.

2. Using the controller, send the command C1 to the 7150; this puts 7150 into the Calibration mode. The flashing CAL annunciator should now stop flashing, and remain permanently on to indicate that Calibration mode has been selected. The word 'CAL' should also appear on the display.

   When the Calibration mode has been entered, the following conditions will apply:

   a) The following three commands cannot be used:

      G(Sample)
      T(Track): this assumes T0 status (equivalent Hold condition)
      Z(Null): this assumes Z0 status and all nulls are deleted.

   b) The additional commands H, L and W become available. These are for use during the calibration sequence.

3.6.3 Calibrating a measurement range

1. Using the controller, send the mode (M) and range (R) commands of the particular mode and range to be calibrated. This will cause the desired mode/range to be selected in the 7150.

   e.g. to calibrate Vdc, 2V range, send "MØR2".

   According to the mode/range to be calibrated, the 7150 must be supplied with two precisely-known reference inputs (non-negative); one at approximately nominal full scale (referred to as the Hi point), and one at approximately zero (referred to as the Lo point). In the case of Vac and Iac the Lo point should be approximately 10% of nominal full scale rather than zero.

After a reference input is applied, the 7150 must be informed of the precise value of the input. This is achieved using the H command for a Hi point and L command for a Lo point. These commands must be accompanied by an integer argument number, of up to six digits in length, which expresses the applied input in terms of a 5 x 9's count. This may be calculated using the formula below.

H or L integer to be entered = applied input x $10^{(7 - R)}$

where R = commanded range number (1 to 6)

e.g. for a 2V input on the 2V range, enter 200000
for a 0.3V input on the 200V range, enter 000300

2. Apply the Hi point input to the 7150 for the particular mode/range.

   e.g. 2.00843V on 2Vdc range

3. Using the controller, send the H command to 7150.

   e.g. H200843

   The 7150 will respond by displaying 'Hi Pt' for approximately 1¼ seconds, during which time it will measure the applied reference input. When finished, the 7150 will display and output its measured count, e.g. 214576. The result may differ from the applied input; this is quite normal.

4. Apply the Lo point input to 7150, for the particular mode/range.

   e.g. 0V short circuit

5. Using the controller, send the L command to the 7150.

   e.g. L0 (leading zeroes need not be specified)

   The 7150 will respond by displaying 'Lo Pt' for approximately 1.5 seconds, during which time it will measure the applied reference input. When finished, the 7150 will display and output the measured count. The result may differ from the applied input; this is quite normal.

6. Having specified Hi point and Lo point (which may in fact be done in either order and repeated if required), send the command W to the 7150. The W command, which has no argument, causes the 7150 to compute and store the appropriate values of calibration constants for the mode/range selected. The display will show the message 'Good' on successful completion of a W command. If W is not successfully completed, an error message will be displayed and output to the controller.

7. Repeat instructions 1 to 6 for each mode/range to be calibrated.

3.6.4 Returning to Normal mode

The 7150 must be taken out of Calibration mode and returned to Normal operating mode (C0), otherwise the calibration data previously entered will not be accepted and an error message will be produced.

NB The shorting jack plug must not be removed from the CAL socket until the 7150 is returned to Normal mode.

1. Using the controller, send the command CØ to the 7150. (The 7150 will then return to Normal operating mode). The CAL annunciator will flash on and off, acting as a warning that the CAL shorting plug is still fitted.

2. Remove the shorting plug from the CAL socket on the 7150 rear panel. The flashing CAL annunciator will then become blank.

3. The 7150 is now ready for normal use.

3.7 SETTING-UP PROCEDURES

3.7.1 Test Equipment

1. Digital Multimeter, e.g. Solartron 7045.

3.7.2 DC Power Supply Checks

Measure the dc supplies on PCB 1 and PCB 2 at the output pins of the appropriate regulator IC, refer to Diag 2.5 in Chapter 2.

PCB 1

VOLTAGE	REGULATOR
-5± 0.2V	IC303
-15± 0.6V	IC304
-25± 1.0V	IC307
+5± 0.2V	IC302
+15± 0.6V	IC301

PCB 2

VOLTAGE	REGULATOR
+5± 0.2V	IC306

3.7.3 Display Checks

Check that all of the elements on the numerical and annunciator displays operate correctly.

The contrast ratio of the display is set by adjusting RV401 to make the digits appear as black as possible but without slurring when a reading changes. The digits should also appear to change quickly from one value to another.

3.7.4 Keyboard Checks

The keys VDC, VAC, KΩ, IDC, IAC and DIODE should be pressed in turn and the display annunciators checked to confirm that the requested mode is shown.

The range keys should be pressed to confirm that ranging up/down works and that AUTORANGE can be selected and deselected. The REMote key can only be checked when the DMM is already in REMOTE. The check is to confirm that the REM annunciator goes out when the key is pressed. The NULL key should be pressed and the display observed for nulling activity. The FILTER key should be pressed and the display checked for FILT annunciator.

3.8 INITIAL CALIBRATION PROCEDURES

3.8.1 Test Equipment

1. General purpose DMM, e.g. Solartron 7045.

2. Controller, e.g. Commodore PET fitted with BASIC II or BASIC IV firmware.

3. Calibrator e.g. Fluke 5101B fitted with GP-IB interface.

4. High Voltage Amplifier, Fluke 5205,

5. ACV Calibrator, Hewlett-Packard 745.

6. ACV High Voltage Amplifier, Hewlett-Packard 746

7. Capacitor, 0.1µF polypropylene attached to a twin 4mm banana plugs $^{3}/_{4}$" centres).

3.8.2 Initial Calibration Tables

The Initial Calibration procedures are detailed in the following tables:

TABLE No.	PROCEDURE
3.1	Initial Calibration DC Volts Range.
3.2	Initial Calibration Resistance Range.
3.3	Initial Calibration DC Current Range.
3.4	Initial Calibration AC Volts Range.

TABLE 3.1 INITIAL CALIBRATION DC VOLTS RANGE

TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
1	a) Fit GPIB connector b) Set address switches to the appropriate address c) Set the TALK ONLY and LISTEN ONLY switches to OFF d) Do NOT insert the Calibration jack plug.				
2	Instrument is unpowered.	Check continuity front-rear sockets for VHI, VLO & GUARD			
3				Power on.	
4				Insert Calibration Key Jack.	
5	Proceed to Test 6				
6	2V range noise test. The reading may jump every 10 sec at drift-correct.	2VDC	s/c VHI - VLO	Check display for scatter.	3 adjacent values
7	Input current measurement. Value may be exceeded at drift-correct.	0.2VDC	o/c	Check reading.	0±400µV
8	Positive input-clamp test (Diode D6).	2VDC	+ve overload of between +4V and +100V	Measure C4 with DMM referred to PCB 1 earth point (ROME)	+3.90 +3.05
9	Negative input-clamp test (Diode D26).	2VDC	-ve overload of between -4V and -100V	As above.	-3.05 -3.90
10	Cal. Bal. adjustment. Continuous drift-correct must be used.	2VDC	±1.99999V alternately	Adjust RV1. CAL BAL.	+ and - equal within 1 bit.
11	+2V set-up	2VDC	+1.99999V & 0.00000V	Do calibration routine over the interface.	

TABLE 3.1 (CONTINUED)

TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
12	+0.2V Set-up. Use the calibrator to deliver 0V.	0.2VDC	0.199999V & 0.000000V	Do calibration routine over the interface.	
13	+20V Set-up.	20VDC	+19.9999V & 0.0000V	Do calibration routine over the interface.	
14	+200V Set-up.	200VDC	+199.999V & 0.000V	Do calibration routine over the interface.	
15	+1kV Set-up. The Calibrator LO and the 7150 LO input should be mains grounded. Check that the spark-gap does not operate. Apply for 1 minute and check that the reading does not drift more than 2 bits.	1kVDC	+1000.00V & 0.00V	Do calibration routine over the interface.	
16				Exit Cal Mode	
17	Linearity check	2VDC	+1.00000V -1.00000V	Measure	± 2 bits
18	1kV step input test. LO and GUARD must be connected to LO of Calibrator and also to mains ground. 7150 must up-range without displaying the power start-up sequence. It is permissible that the spark-gap operates	DC Auto	+1000V applied 5 times	Check display	± 10 bits

TABLE 3.2 INITIAL CALIBRATION RESISTANCE RANGE

TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
1	Input current measurement	20kΩ	DMM between -I and LO	Measure current from -I.	103±5 µA
2	-I 10µA test.	200kΩ	As above	As above	10.3 ± 0.5µA
3	-I 1µA test.	2MΩ	As above	As above	1.03 ± 0.05µA
4	20kΩ range set-up.	20kΩ	10.0000kΩ & 1Ω	Do calibration using the interface.	
5	200kΩ range set-up.	200kΩ	100.000kΩ & 1Ω	Do calibration	
6	2MΩ range set-up 0.1µF in parallel will reduce scatter caused by series mode interference.	2MΩ	1.00000MΩ & 1Ω	Do calibration using the interface.	
7	20MΩ range set-up 0.1µF in parallel will reduce scatter.	20MΩ	10.0000MΩ & 1Ω	Do calibration using the interface.	
8	Ω source positive clamp.	2MΩ	DMM across 7150 HI & LO	Measure the o/c volts from Ω source.	+5.7V ± 1V
9	Ohms overload test.	2MΩ	240VAC mains	Apply VHI-VLO 10 seconds.	
10	Survival check for damage after test 9.	2MΩ	1.00000MΩ	Check after test 9.	1.00000MΩ ± 2 bits

TABLE 3.3. INITIAL CALIBRATION DC CURRENT RANGE

TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
1	1 Ampere Set-up. Do immediately.	DC 2A	+1.00000A & open circuit	Calibrate over the bus.	
2	2 Ampere Set-up. Do immediately.	DC 2A	400 Hz 1.99999A & 0.19999A	Calibrate over the bus.	
3				Exit Cal Mode.	
5		DC 2A	+1.99999A	Measure voltage at current front sockets with a DMM.	0.80V

TABLE 3.4. INITIAL CALIBRATION AC VOLTS RANGE

TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
1	IC15 offset null adjust Use DMM to monitor TP3.	20VAC	s/c	Adjust RV2 for minimum @ TP3	±100µV referred to 0V
2	Fluke 5101	200VAC	199.999V 400Hz	Note reading	
3	Attenuator HF trim. Fluke 5101 + 5205 100 bit limit applies when a dummy lid is fitted. If no lid is fitted a lift is required of 1000 bits for a metallised case	200VAC	199.999V 50kHz	Adjust CV1 and the position (i.e. stray capacitance affects) of R10 for level response. CV1 to be adjusted with PCB 1 assembled to the screening board.	Value at test '2' ± 0.100V
4	2V LF Set-up Fluke 5101	2VAC	1.999999V & 0.199999V 400Hz	Calibrate over the bus.	
5	20V Set-up Fluke 5101	20VAC	19.99999V & 1.9999V 400Hz	Calibrate over the the bus.	
6	200V Set-up Fluke 5101	200VAC	199.999V & 19.999V 400Hz	Calibrate over the bus.	
7	1kV Set-up Fluke 5101	1kVAC	750.00V & 150.00V 400Hz	Calibrate over the bus.	
8				Exit Cal Mode.	
9	Fluke 5101	2VAC	10 kHz 1.99999V	Check	1.99999V ± 0.00215V
10	Fluke 5101	2VAC	30 kHz 1.99999V	Check	1.99999V ± 0.00320V
11	Fluke 5101	20VAC	30 kHz 19.9999V	Check	19.9999V ± 0.00320V

TABLE 3.4 (CONTINUED)

TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
12	Fluke 5101	20VAC	10kHz 19.9999V	Check	19.9999v ± 0.0215V
13	Fluke 5101 + 5205	200VAC	10kHz 199.999V	Check	199.999V ± 0.215V
14	Fluke 5101 + 5205	200VAC	30kHz 199.999V	Check	199.999V ± 0.320V
15	Fluke 5101 + 5205	1kVAC	10kHz 750.00V	Check	750.00v ± 1.15V
16	Fluke 5101 + 5205	1kVAC	30kHz 750.00V	Check	750.00V ± 2.20V
17	s/c zero	2VAC	s/c	Check	5 mV
18	HP 745	2VAC	10Hz 2.00000V	Check	2.00000V ± 0.01500V
19	HP 745	2VAC	20Hz 2.00000V	Check	2.00000V ± 0.00450V
20	HP 745	2VAC	40Hz 2.00000V	Check	2.00000V ± 0.00215V
21	HP 745	2VAC	100kHz 2.00000V	Check	2.00000V ± 0.01040V
22	HP 745	20VAC	100kHz 20.0000V	Check	20.0000V ± 0.1040V
23	HP 745 + HP 746	200VAC	100kHz 200.000V	Check	200.000V ± 1.040V
24	750VAC Autorange test. LO and GUard must connect to LO of Calibrator and also to mains ground. 7150 must uprange without displaying the power start-up sequence.	2VAC Auto	750V/400Hz applied 5 times	Check	750.00 ± 1.50V

3.9 FINAL CALIBRATION PROCEDURES

3.9.1 Test Equipment

1. Calibrator test equipment as detailed in Section 3.8.1.
2. Optional calibration standard resistors, manufactured by Mann Components, 20k ohms + 200k ohms + 2M ohms + 20M ohms.

3.9.2 Final Calibration Tables

The 7150 should be fully cased and placed in an 20°C environment for at least four hours and switched on for at least two hours prior to final calibration. GUARD and LO inputs should be mains grounded to minimise series - mode interference. The use of screened leads for HI ohms also minimises series - mode interference.

The top of the section case is removed during calibration but is fitted when the final calibration recheck is performed.

Note that the four screws which retain the top section of the case must be fully tightened to make the case screening effective. The A.C. ranges may have to be re-calibrated to compensate for the affects of the case screening.

The final calibration procedures are detailed in the following tables:

TABLE No.	PROCEDURE
3.5	Final Calibration DC volts Range.
3.6	Final Calibration Resistance Range.
3.7	Final Calibration AC volts Range.
3.8	Final Calibration DC and AC Current Ranges.
3.9	Final Calibration Recheck.
3.10	DC and AC Common Mode Rejection.

TABLE 3.5. FINAL CALIBRATION DC VOLTS RANGE

TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
1	200mV range Cal. Zero volts to be commanded from Calibrator.	0.2VDC	+0.199999V & 0.000000V	Calibrate over the bus.	
2	2V range Cal. Zero volts from Calibrator on its 2 volt range.	2VDC	+0.199999V & 0.000000V	Calibrate over the bus.	
3	20V range Cal. Zero volts from Calibrator on its 20 volt range.	20VDC	+19.9999V & 0.00000V	Calibrate over the bus.	
4	200V range Cal. Zero volts from Calibrator.	200VDC	+199.999V & 0.000V	Calibrate over the bus.	
5	1kV range Cal.	1kVDC	+1000.00V & 0.00V	Calibrate over the bus.	

TABLE 3.6 FINAL CALIBRATION RESISTANCE RANGE

TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
1	Mann Standard resistors. Value entered for calibration is the known value of the Standard. 4-terminal connection to be used. Fluke. 4-terminal connections as follows 7150 I+ & I- connect to Fluke "output" 7150 HI & LO connect Fluke "sense"	20kΩ	20kΩ Standard and s/c OR 10kΩ & 1Ω from Fluke	Calibrate over the bus. Calibrate over the bus.	
2	Mann Standard resistors. Fluke 5101	200kΩ	200kΩ Standard and s/c OR 100kΩ & 1Ω from Fluke	Calibrate over the bus. Calibrate over the bus	
3	Mann Standard resistors. Use screened lead. Fluke 5101. Use screened lead.	2MΩ	2MΩ Standard and s/c OR 1MΩ & 1Ω from Fluke	Calibrate over the bus. Calibrate over the bus.	
4	Mann standard resistors. Use screened lead. Fluke 5101. Use screened lead.	20MΩ	20MΩ Standard and s/c OR 10MΩ & 1Ω from Fluke	Calibrate over the bus. Calibrate over the bus.	

TABLE 3.7 FINAL CALIBRATION AC VOLTS RANGE

TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
1	2VAC	2VAC	1.99999V & 0.19999V @ 400Hz	Calibrate over the bus.	
2	20VAC	20VAC	19.9999V & 1.9999V @ 400Hz	Calibrate over the bus.	
3	200VAC	200VAC	199.999V & 19.999V @ 400Hz	Calibrate over the bus.	
4	1kVAC	1kVAC	750.00V & 150.00V 400Hz	Calibrate over the bus.	

TABLE 3.8 FINAL CALIBRATION DC AND AC CURRENT RANGES

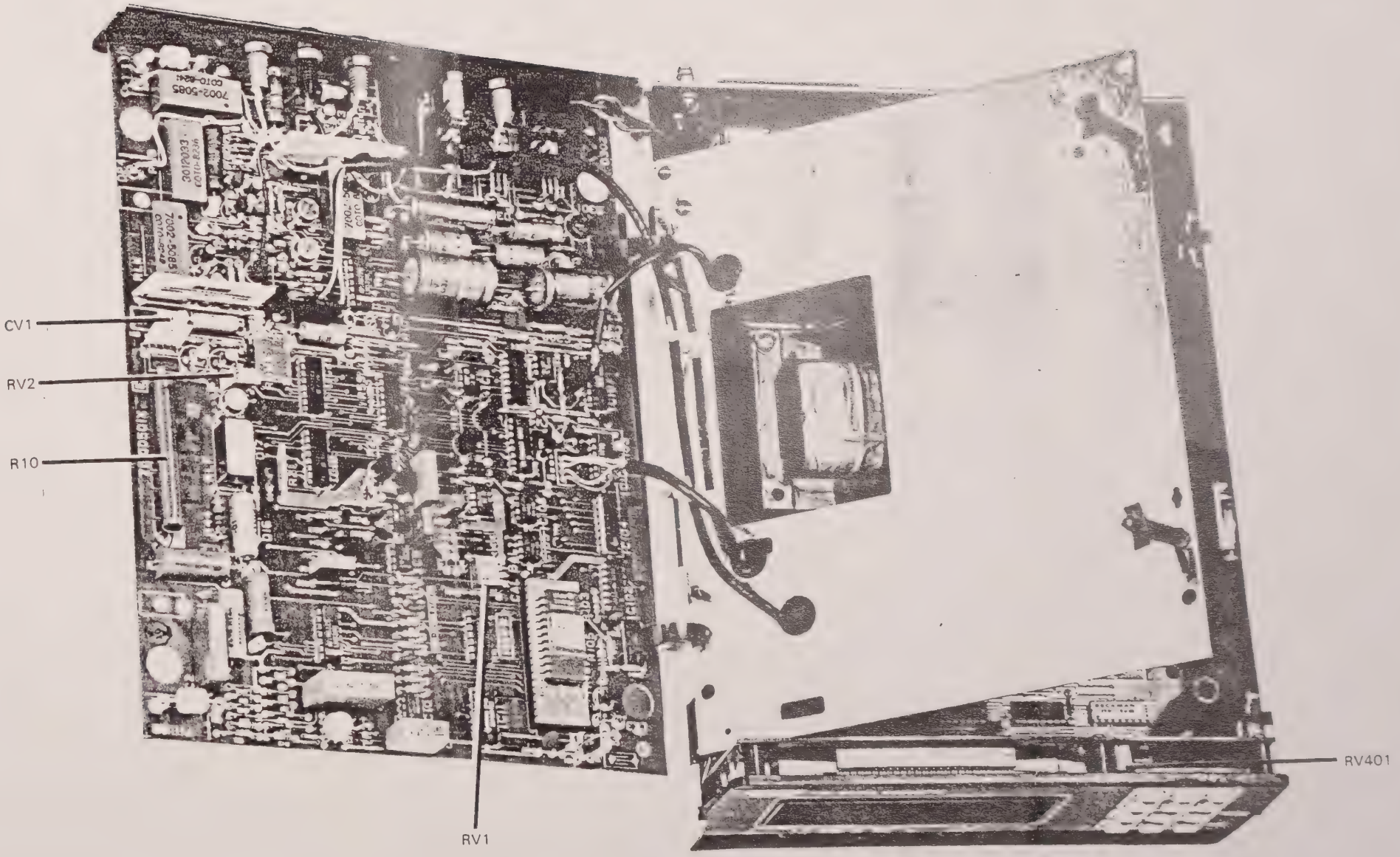
TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
1	Allow reading to settle (thermal effect) before calibrating. Settling time is approximately 1 minute.	2ADC	1.00000A and o/c	Calibrate over the bus.	
2	Allow reading to settle before calibrating.	2A AC	1.99999A & 1.9999A @ 400Hz	Calibrate over the bus.	

TABLE 3.9 FINAL CALIBRATION RECHECKS

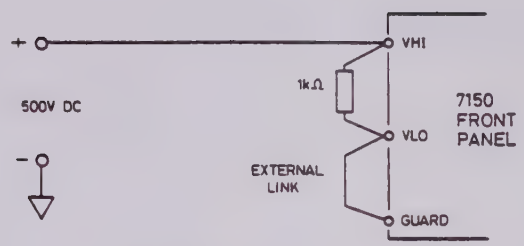
TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
1		0.2VDC	-0.199999V	Check	8 bits
2		2VDC	-1.99999V	Check	8 bits
3		20VDC	-19.9999V	Check	8 bits
4		200VDC	-199.999V	Check	8 bits
5		1kV DC	-1000.00V	Check	6 bits
6 to 10	Proceed with Test II				
11		2VAC	1.99999V 400Hz	Check	215 bits
12		20VAC	1.99999V 400Hz	Check	215 bits
13		200VAC	19.9999V 400Hz	Check	215 bits
14		1kVAC	750.00V 400Hz	Check	115 bits
15		20VAC	19.9999V 50kHz	Check	300 bits
16		20kΩ	10.0000kΩ	Check	8 bits
17		200kΩ	100.000kΩ	Check	8 bits
18		2MΩ	1.00000MΩ	Check	8 bits
19		20MΩ	10.0000MΩ	Check	8 bits
20		2ADC	1.00000A	Check	20 bits
21		2A AC	1.99999A/ 400Hz	Check	100 bits

TABLE 3.10 AC AND DC COMMON MODE REJECTION

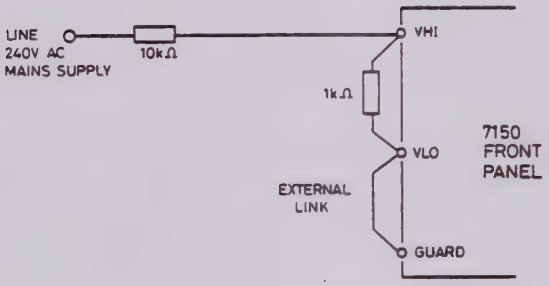
TEST	DESCRIPTION	RANGE & MODE	INPUT	ACTION	LIMITS
1	DC Common Mode Rejection 120dB	DC Auto	Refer to Fig 3.2	Check display.	0 + 500µV
2	AC Common Mode Rejection 120dB	DC Auto	Refer to Fig 3.3	Check display.	0 ± 340µV



CALIBRATION PRESET CONTROLS
FIG 3.1



TEST CIRCUIT FOR DC COMMON
MODE REJECTION



TEST CIRCUIT FOR AC COMMON
MODE REJECTION

FIG 3.2 COMMON MODE REJECTION TEST CIRCUITS

CHAPTER 4
DISMANTLING AND REASSEMBLING INSTRUCTIONS

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4.1 GENERAL

The 7150 must be disconnected from the mains supply before proceeding with these instructions. Refer to Fig 3.1 and 4.1 when using these instructions.

4.2 DISMANTLING

1. Pivot the carrying handle to the rear of the case. Pull out the handle lugs from the pivot points on each side of the case and remove the handle.

2. Remove the four screws from the bottom of the case and then withdraw the top section of the case to expose the copper track side of PCB 1.

3. Compress the two plastic snap fasteners, located on the right hand side of PCB 1 (as viewed from the unit front) to release the pcb. Pivot the pcb outwards to gain access to the board components and to expose the screening pcb and the mains transformer.

4. Remove the two screws from the holes located in the mains transformer laminations and withdraw the complete instrument assembly from the bottom section of the case. PCB 2 can now be accessed by unclipping the plastic stand-off fasteners which retain the screening board to PCB 2.

5. At the left of the front panel assembly, remove the self-tapping screw which secures the front panel assembly to a clip on PCB 2. Unplug the front panel assembly from PCB 2.

6. To gain access to PCB 3, remove the six screws which secure the pcb to the front panel. Note that PCB 3 remains attached to the front panel by the keyboard ribbon cable.

4.3 REASSEMBLING

1. Fit PCB 3 to the front assembly using the six screws.

2. Carefully plug the front panel assembly into PCB 2. Check that all of the connecting pins on the front panel assembly are correctly inserted into the socket pins on PCB 2.

3. Fit the self-tapping screw which secures the front panel assembly to PCB 2.

4. Attach the screening pcb to PCB 2 by use of the plastic stand-off fasteners.

5. Insert the complete instrument assembly into the bottom section of the case. Insert the two screws into the holes on the mains transformer laminations and tighten to secure the bottom section of the case.

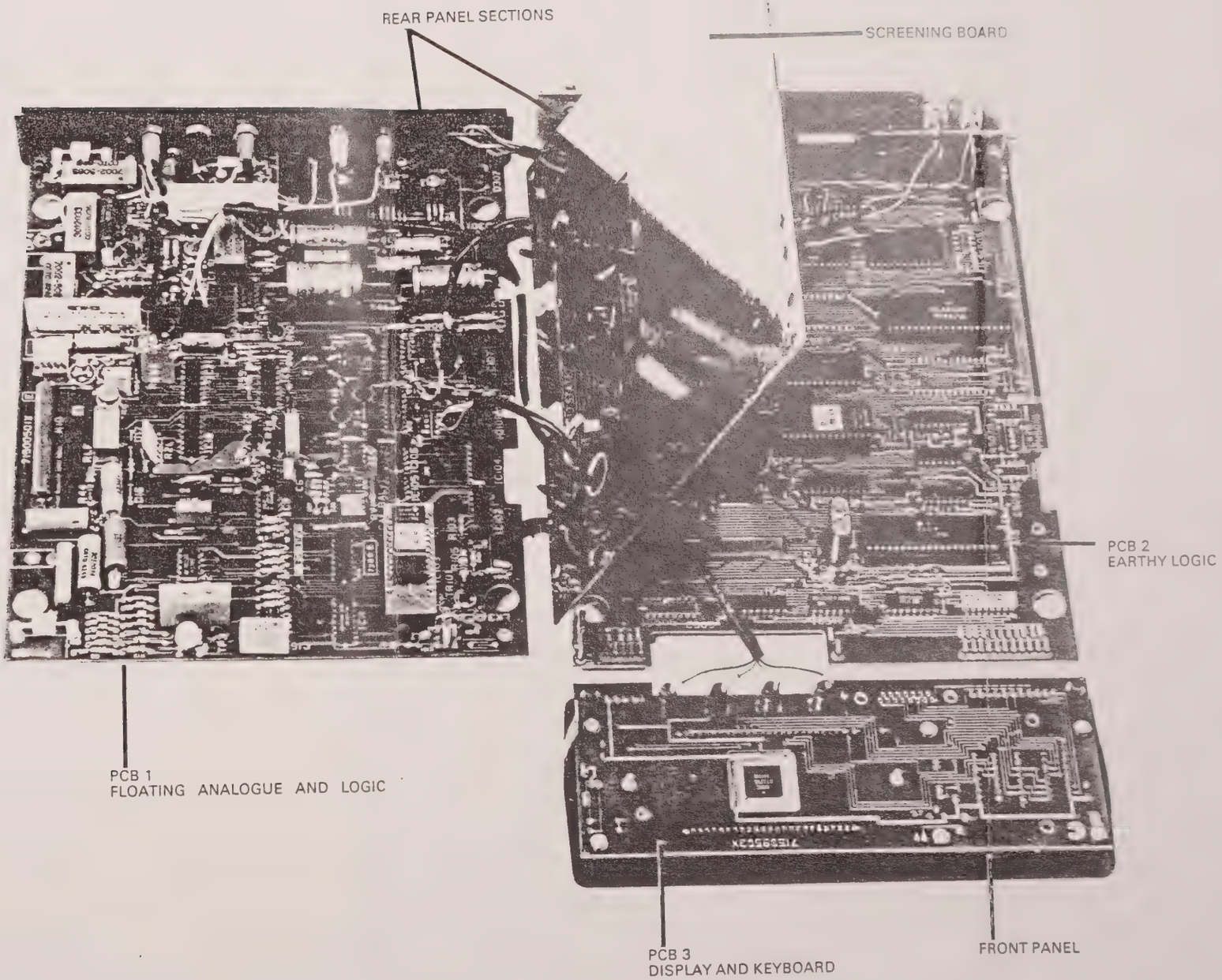
6. Secure PCB 1 by use of the two plastic snap fasteners located on the right hand side of the pcb.

7. Dress the cables on the top of the screening board clear of the holes in the board which locate the extended lugs in the top section of the case.

8. Insert the top section of the case onto the instrument assembly and secure the top section to the bottom section by the four screws inserted into the bottom section of the case.

   NOTE: It is important that these four screws are fully tightened otherwise the case screening is made ineffective and consequently the ac calibration could be impaired.

9. Fit the handle by lining up the locating lugs on the handle with the pivot points on each side of the case and then press the handle lugs into the pivoting points on the case.


REAR PANEL SECTIONS
SCREENING BOARD
PCB 2
EARTHY LOGIC
PCB 1
FLOATING ANALOGUE AND LOGIC
PCB 3
DISPLAY AND KEYBOARD
FRONT PANEL

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ILLUSTRATIONS

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5.1 INTRODUCTION

This section contains component layout diagrams and detailed parts lists for each of the three printed circuit boards and the front and rear panels. When ordering spare parts, it is essential to quote the instrument serial number located on the rear panel as well as the full description of the item given in the appropriate parts list.

A description of the abbreviations used in the parts list is given as follows:

COMPONENT PARTS LIST ABBREVIATIONS

CIRCUIT REFERENCES

AE	Aerial
B	Battery
C	Capacitor (μF)
CSR	Thyristor
D	Diode
FS	Fuse
IC	Integrated Circuit
L	Inductor
LP	Lamp (including Neon)
LK	Link
M	Motor
ME	Meter
MSP	Mains Selector Panel
PL	Plug
R	Resistor (Ω)
RE	Recording Instrument
RL	Relay
S	Switch
SK	Socket
T	Transformer
TP	Terminal Post (or Test Point)
TR	Transistor
V	Valve
X	Other Components

Also Used:-

RNL	Non Linear Resistor (Ω)
RV	Variable Resistor (Ω)

COMPONENT TYPES

Fixed Resistors		Variable Resistors		Capacitors	
Carbon Composition	CACP	Carbon Front Panel Multiturn	CAFM	Air	AIR
Carbon Film	CAFM	Carbon Front Panel Single Turn	CAFS	Aluminium Electrolytic	ALME
Cracked Carbon	CKCA	Carbon Preset Multiturn	CAPM	Aluminium Solid	ALMS
Metal Film	MEFM	Carbon Preset Single Turn	CAPS	Polycarbonate	CARB
Metal Oxide	MEOX	Cermet Front Panel Multiturn	CMFM	Ceramic	CERM
Power Wirewound	POWW	Cermet Front Panel Single Turn	CMFS	Polyester Foil	ESTF
Precision Wirewound	PRWW	Cermet Preset Multiturn	CMPM	Polyester Metallised	ESTM
Temperature Sensitive	TEMP	Cermet Preset Single Turn	CMPS	Glass	GLAS
Thick Film	TKFM	Wirewound Front Panel Multiturn	WWFM	Mica	MICA
Thin Film	TNFM	Wirewound Front Panel Single Turn	WWFS	Metallised Lacquer	MLAC
Voltage Sensitive	VOLT	Wirewound Preset Multiturn	WWPM	Paper Foil	PAPF
		Wirewound Preset Single Turn	WWPS	Paper Metallised	PAPM
				PTFE	PTFE
				Polypropylene Film	PYLN
				Polystyrene	STYR
				Tantalum Dry	TAND
				Tantalum Foil	TANF
				Tantalum Wet	TANW

5.2 PCB 1 (71500501) FLOATING ANALOGUE AND LOGIC

Cct Ref.	General Description				Solartron Part No.
R1	MEFM	CAD 1776			160400583
R2	MEOX	1k	0.25W	5%	195631000
R3	POWW	0.1			160300457
R4	MEGL	22k	3W	5%	176442200
R5	CACP	10k	0.5W	10%	172341000
R6	MEFM	1.2k	0.125W	0.5%	192731202
R7	MEFM	30k	0.125W	0.5%	192743002
R8	MEOX	100k	0.25W	5%	195651000
R9	MEGL	100k	3W	2%	175251000
R10	MEFM	990k	2W	0.5%	160400487
R11	TKFM	1k+9k	0.2W	1%	160400582
R12	MEOX	3.3k	0.25W	5%	195633300
R13	MEOX	1k	0.25W	5%	195631000
R14	-	1.452k	0.2W	0.25%	160300452
R15	TKFM	CAD 1776			160400583
R16	-	9k	0.2W	0.25%	160300456
R17	MEFM	10k	0.125W	0.5%	192741004
R18	-	9k	0.2W	0.25%	160300456
R19	-	1k	0.2W	0.25%	160300454
R20	-	100k	0.2W	0.25%	160300455
R21	TKFM	1k+9k	0.2W	1%	160400582
R22	MEOX	33k	0.25W	5%	195643300
R23	MEFM	39k	0.125W	0.5%	192743902
R24	-	67k	0.2W	0.25%	160300453
R25	MEFM	3.3k	0.125W	0.5%	192733302
R26	MEOX	33k	0.25W	5%	195643300
R27	MEFM	270k	0.125W	0.5%	192752701
R28	MEOX	1k	0.25W	5%	195631000
R29	MEOX	100	0.25W	5%	195621000
R30	MEOX	100k	0.25W	5%	195651000
R31	MEOX	100k	0.25W	5%	195651000
R32	MEOX	22k	0.25W	5%	195642200
R33	MEOX	1k	0.25W	5%	195631000
R34	MEOX	100	0.25W	5%	195621000
R35	MEOX	4.7k	0.25W	5%	195634700
R36	MEOX	4.7k	0.25W	5%	195634700
R38	MEFM	10k	0.125W	0.5%	192741004
R39 to R41	MEOX	33k	0.25W	5%	195643300
R42	MEFM	100	0.125W	0.5%	192721002
R43	MEOX	4.7k	3W	5%	193734700

PCB 1 (CONTINUED)

Cct Ref.	General Description				Solartron Part No.
R44	CACP	1M	0.5W	10%	172341000
R45	MEOX	100k	0.25W	5%	195651000
R46	MEOX	1k	0.25W	5%	195631000
R47	MEOX	100	0.25W	5%	195621000
R48	MEOX	100	0.25W	5%	195621000
R49	MEFM	200k	0.125W	0.5%	192752002
R50	MEFM	1M	0.25W	0.5%	198261002
R51	MEFM	62k	0.125W	0.5%	192746202
R52	MEOX	33k	0.25W	5%	195643300
R53	MEOX	1k	0.25W	5%	195631000
R54	MEOX	56	0.25W	10%	195615600
R55	CACP	10k	0.5W	10%	172341000
R56	CACP	2.7M	0.125W	10%	172062700
R57	MEFM	10k	0.125W	0.5%	192741004
R59	MEOX	1k	0.25W	5%	195631000
R61	MEOX	180	0.25W	5%	195621800
R62	MEOX	180	0.25W	5%	195621800
R63	MEOX	10k	0.25W	5%	195641000
R64	MEOX	22k	0.25W	5%	195642200
R65	MEOX	22k	0.25W	5%	195642200
R66	MEOX	82k	0.25W	5%	195648200
R101	MEOX	15k	0.25W	5%	195641500
R103	MEOX	270	0.25W	5%	195622700
R104	MEOX	1.5k	0.25W	5%	195631500
R105	MEOX	100	0.5W	1%	195421000
R301	MEOX	47k	0.25W	5%	195644700
R302	MEOX	180	0.25W	5%	195621800
RV1	CMPM	200	0.5W	10%	131222000
RV2	CMPM	200k	0.5W	10%	130952000
C1	CERM	150p	500V	20%	241321500
C2	ESTM	0.22	400V	20%	226152200
C3	EFTF	0.01	1000V	10%	222841000
C4	STYR	470p	125V	10%	210224700
C5	ESTF	22n	400V	10%	222342200
C6	ESTM	15n	100V	10%	225441500
C7	ESTM	0.47	100V	10%	225454700
C8	ESTM	0.22	100V	10%	225452200

PCB 1 (CONTINUED)

Cct Ref.	General Description				Solartron Part No.
C10	CERM	47n	25V	+50% -25%	241944700
C11	CERM	47n	25V	+50% -25%	241944700
C12	CARB	100p	160V	20%	208900004
C13 to C15	CERM	47n	25V	+50% -25%	241944700
C16	ESTM	1	100V	10%	225461000
C17	ESTM	2.2	100V	10%	225462200
C18 to C23	CERM	47n	25V	+50% -25%	241944700
C24	CERM	4.7p	500V	20%	241304700
C25	CERM	47n	25V	+50% -25%	241944700
C26	CERM	47p	500V	20%	241314700
C27	CERM	150p	25V	+50% -25%	241321500
C28	CERM	47p	500V	20%	241314700
C101	CERM	33p	500V	20%	241313300
C102	CERM	33p	500V	20%	241313300
C103	TAND	22	16V	20%	208700106
C104 to C108	CERM	47n	25V	+50% -25%	241944700
C109	CERM	1	500V	20%	241331000
C110	CERM	47n	25V	+50% -25%	241944700
C301	ALME	2200	16V	-10% +25%	273392200
C302	ALME	220	16V	-10% +25%	273382200
C303	ALME	1000	40V	-10% +25%	273791000
C304	ALME	470	40V	-10% +25%	273784700
C305	ALME	100	25V	-10% +25%	273581000
C306	ALME	100	25V	-10% +25%	273381000
C308 to C311	TAND	1	35V	20%	266061000
C313	CERM	47n	25V	+50% -25%	208450140
CV1	PTFE	2-14p			290060030

PCB 1 (CONTINUED)

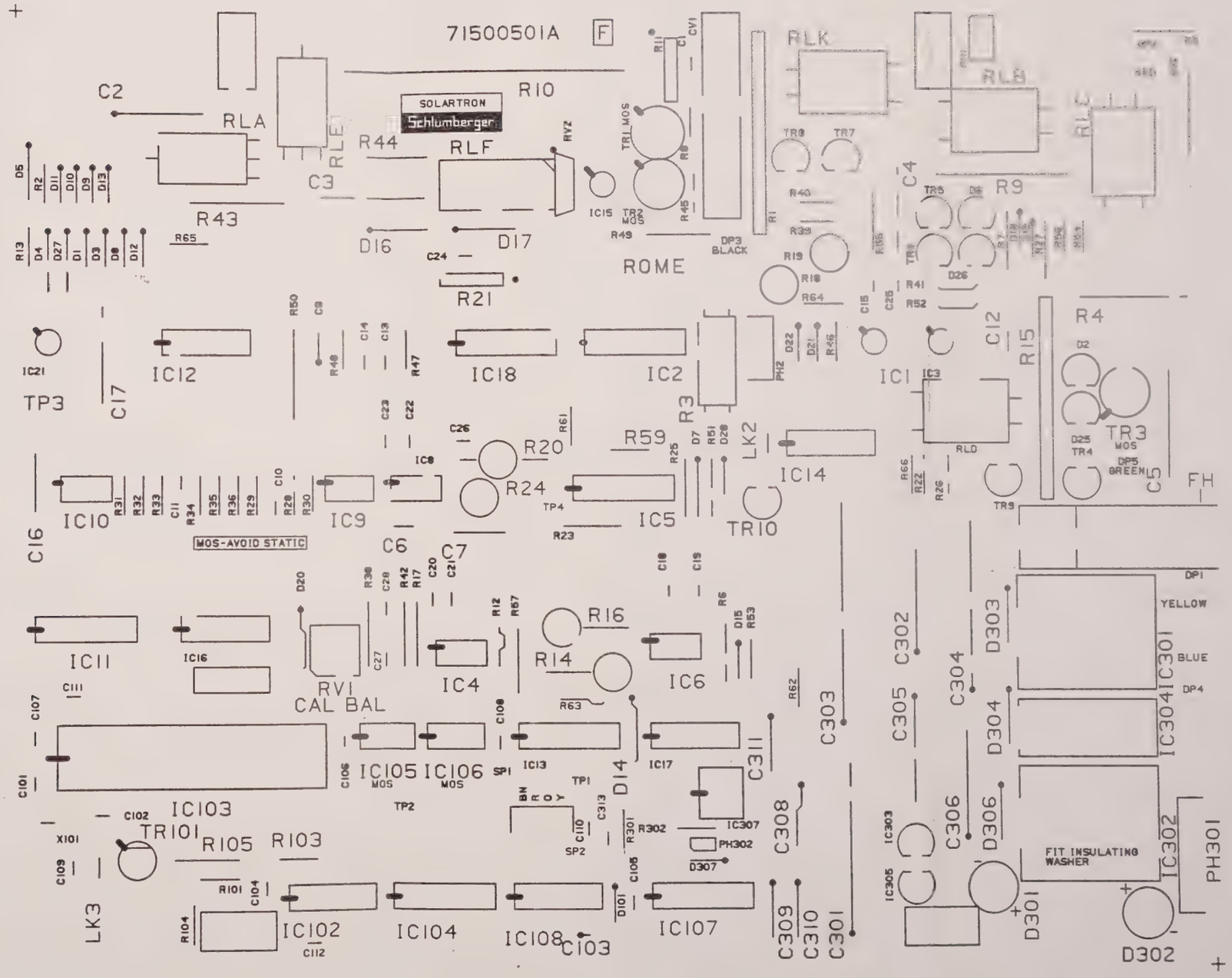
Cct Ref.	General Description		Solartron Part No.
D1	SD3		300522160
D2	WR057		300525770
D3	SD3		300522160
D4	BZY88	5.6V	300521450
D5	BZY88	8.2V	300521330
D6	WR057		300525770
D7	BZY88	8.2V	300521330
D8 to D13	SD3		300522160
D15	SD3		300522160
D16	IN3595		300523590
D17	IN3595		300523590
D18	SD3		300522160
D19	SD3		300522160
D20	IN829A		300525400
D21	SD3		300522160
D22	SD3		300522160
D25	WR057		300525770
D26	WR057		300525770
D27	BZY88	2.7V	300523870
D101	SD3		300522160
D301	W04	400V	300524700
D302	W04	400V	300524700
D303	IN4004	400V	300522070
D304	IN4004	400V	300522070
D306	Zener	20V	300523790
D307	SD3		300522160
TR1	3N163		300554530
TR2	3N163		300554530
TR3	3N163		300554530
TR4	WN1001		300555770
TR5	WN1001		300555770
TR6	WN1001		300555770
TR7	PN4118A		300555880
TR8	WN1001		300555770
TR9	WN1001		300555770
TR10	U1897		300553800
TR101	BC183		300555590

PCB 1 (CONTINUED)

Cct Ref.	General Description	Solartron Part No.
IC1	AD545	510090740
IC2	DG211	510091180
IC3	AD545	510090740
IC4	OP-05	510091130
IC5	DG211	510091180
IC6	OP-14	510091360
IC8	OP-14	510091360
IC9	LM311	510091280
IC10	LM311	510091280
IC11	74LS175	510003170
IC12	LM339	510090490
IC13	ULN2003	510004980
IC14	LM339	510090490
IC15	LH0062CH	510090380
IC16	DG200	510091170
IC17	74LS00	510002000
IC18	DG211	510091180
IC21	AD536AK	510090770
IC102	74LS04	510002690
IC103	HD63A01V1B04P	519611701
IC104	6.8k	160400569
IC105	NC7033	510005150
IC106	NC7033	510005150
IC107	4040BE	510001820
IC108	74LS197	510005750
IC301	7815 CKC	510090320
IC302	LM340TS	510090500
IC303	79L05ACZ	510090950
IC304	7915	510090330
IC305	19L05ACZ	510090950
IC307	TIL 117	300540240

PCB 1 (CONTINUED)

Cct Ref.	General Description	Solartron Part No.
PH1	Header 2 way	352302080
PH2	Header 4 way	352304080
PH301	Header 8 way	352308060
PH302	Header 2 way	352302080
SG2	Spark Gap 1400V	300011470
F1	Fuse Holder	360206040
FH1	Fuse 2A 5mm x 20mm	360106150
RLA	Coto 4000-0002	301203401
RLB	Coto 7002-5005	301203301
RLC	Coto 7002-5085	301203501
RLD	Coto 7002-5086	301203601
RLE	Coto 4000-0002	301203401
RLF	RS12	300652190
RLK	Coto 7002-5085	301203501
X101	4.9152MHz	300810590
	MPU 40-Pin Socket	300585190
	GPIA 40-Pin Socket	300585190
	PROM 28-Pin Socket	300585160
	Ceramic Bead	470120100


71500501A
F
SOLARTRON
Schlumberger
C2
RLA
R10
RLE
R44
RLF
C3
R43
D16
D17
C24
R21
ROME
DP3
BLACK
RLK
RLB
RLC
R9
C4
R40
R39
R19
R18
R64
R41
R52
R4
C12
R15
IC21
TP3
C17
IC12
IC18
IC2
R3
IC1
IC3
RLD
TR3
MOS
DP5
GREEN
C5
FH
R20
R24
R59
LK2
IC14
TR10
IC10
IC9
C6
C7
C16
MOS-AVOID STATIC
IC5
R23
TP4
DP1
YELLOW
BLUE
DP4
IC304
IC301
C302
D303
C304
C305
D304
C306
D306
C303
C311
C308
C309
C310
C301
D301
D302
IC302
PH301
FIT INSULATING
WASHER
IC11
IC16
RV1
CAL BAL
IC4
R16
R14
IC6
R63
IC105
IC106
MOS
IC13
IC17
D14
IC103
TR101
TP1
TP2
SP1
SP2
IC307
PH302
D307
R302
R105
R103
LK3
IC102
IC104
IC108
IC107
C103

5.3 PCB 2 (71500502) EARTHY LOGIC

Cct Ref.	General Description				Solartron Part No.
R501	MEOX	12k	0.25W	5%	195641200
R502	MEOX	12k	0.25W	5%	195641200
R505	MEOX	270	0.25W	5%	195622700
R506	MEOX	3.3k	0.25W	5%	195633300
R507	MEOX	1k	0.25W	5%	195631000
R508	CACP	10	0.125W	10%	172011000
R509	MEOX	15k	0.25W	5%	195641500
R510	MEOX	1k	0.25W	5%	195631000
R511	MEOX	1k	0.25W	5%	195631000
C307	ALME	2200	16V		273392200
C312	ALME	2200	16V		273392200
C501	CERM	33p	500V	20%	241313300
C502	CERM	33p	500V	20%	241313300
C503	CERM	47n	25V	+50% -25%	241944700
C504 to C511	CERM	47n	25V	+50% -25%	241944700
C512	CERM	47n	25V	+50% -25%	241944700
C513	CERM	47n	25V	+50% -25%	241944700
C514	CERM	1n	500V	20%	241331000
C515	CERM	10n	25V	+50% -20%	241941000
C516	CERM	10n	25V	+50% -25%	241941000
C517	CERM	1n	500V	20%	241331000
D305	W04	400V			300524700
D501	SD3				300522160
D502	SD3				300522160
IC306	LM340T5				510090500
IC501	MC3447				510005700
IC502	MC3447				510005700
IC503	MC68488				510004291

PCB 2 (CONTINUED)

Cct Ref.	General Description	Solartron Part No.
IC506	TC5516	510005470
IC508	2654	510005610
IC509	LS373	510004870
IC510	HD6303P	510006170
IC511	LS374	510004390
IC512	LS138	510003530
IC513	LS145	510004990
IC514	AB316A682	160400569
IC515	LS00	510002000
IC516	MC14040	510001820
IC517	LS197	510005750
IC518	HCPL 2601	300540260
IC519	HCPL 2601	300540260
IC520	LS04	510002690
S501	Switch	375000600
SK501	GPIB socket	352524320
PH501	4 Way Header post	352304080
T301	Transformer	309617106
X501	2.4576 MHz Crystal	300810420
IC503 socket		300585190
IC508 socket		300585160
IC510 socket		300585190

5.4 PCB 3 (71500503) DISPLAY AND KEYBOARD

Cct Ref.	General Description				Solartron Part No.
R401	MEOX	180k	0.25W	5%	195651800
R402	MEOX	1.8k	0.25W	5%	195631800
R403	MEOX	1.2k	0.25W	5%	195631200
R404	MEOX	270	0.25W	5%	195622700
R405	MEOX	270	0.25W	5%	195622700
RV401	CMPM	10k	0.5W	10%	130641000
C401	CERM	47n	25v	+50% -25%	241944700
C402	CERM	47n	25V	+50% -25%	241944700
D401 to D404	LED HP5082 - 4558				300750270
TR401	BC183				300555590
IC401	NEC 7225G				510005890
IC402	74LS145				510004990
IC403	316B 6.8k				192136800
SK402	25 way				352525090
SK403	25 way				352525090
KB401	Keyboard Matrix				71502019A
X401	Liquid Crystal Display				71502006A

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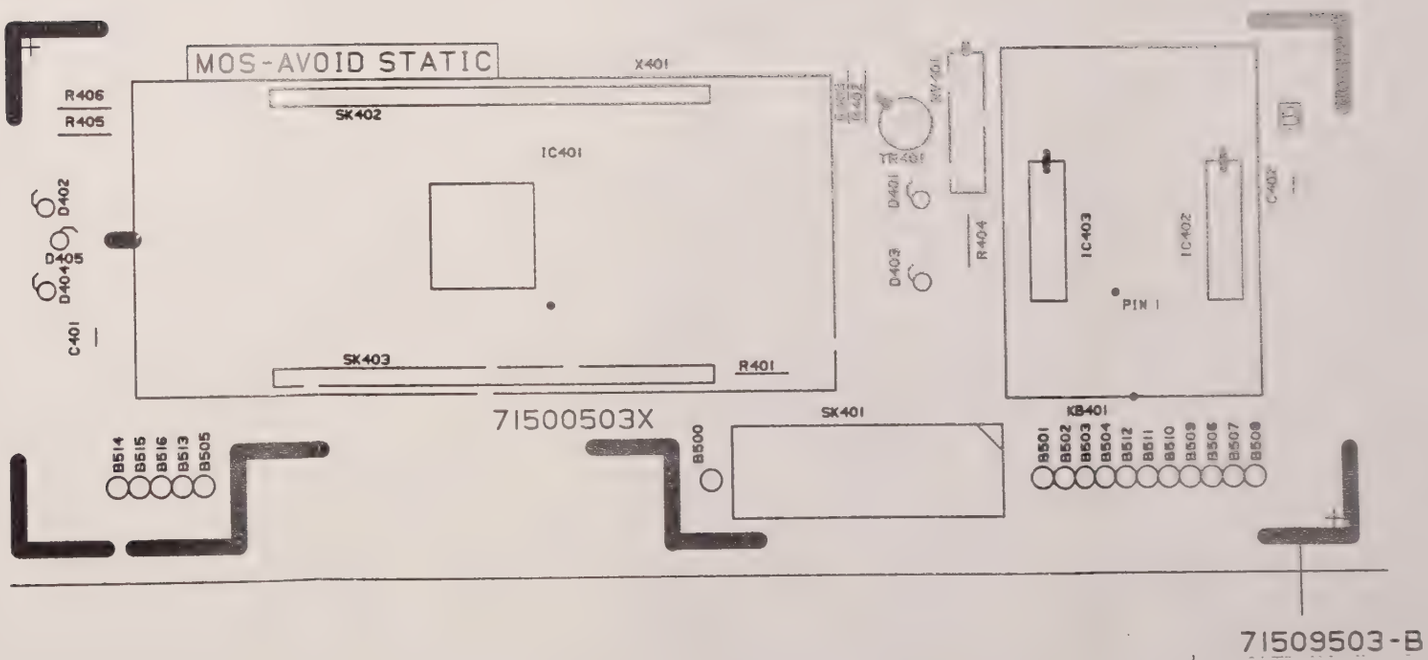
FLAG 5.2


MOS-AVOID STATIC
X401
SK402
IC401
R406
R405
D402
D405
D404
C401
SK403
R401
71500503X
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B500
B514
B515
B516
B513
B505
SW401
TR401
D401
D403
R404
IC403
IC402
C402
PIN 1
KB401
B501
B502
B503
B504
B512
B511
B510
B509
B506
B507
B508
71509503-B

5.5 FRONT PANEL

Cct Ref.	General Description	Solartron Part No.
	Socket Red 4mm	352501470
	Socket Black 4mm	352501480
	Socket Brown 4mm	352501750
	Socket Green 4mm	352501490

5.6 REAR PANEL

Cct Ref.	General Description	Solartron Part No.
R303	Resistor 1MΩ	172361000
FH1	Fuse Fast Blow 2A	360106150
	Fuse Slow Blow 100mA	360106260
S301	Mains switch	375500020
SK503	Jack Socket	352501740
SK504	Jack Socket	352501740
N301	Mains Input Unit	550001480
	Socket Red 4mm	352501470
	Socket Black 4mm	352501480
	Socket Green 4mm	352501490
	Socket Blue 4mm	352501710
	Socket Yellow 4mm	352501720

5.7 POWER SUPPLIES

The power supply components are distributed between PCB 1, PCB 2 and the rear panel, refer to the appropriate parts list.

K&M Company
TORRANCE, CA 90503

www.manualsplus.com
1028387